# Information geometry of mean-field approximation for third-order classical and quantum Boltzmann machines

N Yapage*
Department of Mathematics
University of Ruhuna
Matara
Sri Lanka

**Abstract**

We apply the concepts of information geometry to study the mean-field approximation for a general class of quantum statistical models namely the higher-order quantum Boltzmann machines (QBMs). The states we consider are assumed to have at most third-order interactions with deterministic coupling coefficients. The totality of such states can be shown to form a quantum exponential family and thus can be viewed as a smooth manifold. In our work, we explicitly obtain naive mean-field equations for the third-order classical and quantum Boltzmann machines and demonstrate how some information geometrical concepts, particularly, exponential and mixture projections are useful in the more general case. It is obvious that our results for third order clasical Boltzmann machines (CBMs) and QBMs emphasize the validity and the importance of information geometrical point of view for higher dimensional classical and quantum statistical models.

**Keywords:** mean-field theory, quantum statistical model, information geometry, quantum relative entropy, quantum exponential family

*nihal@maths.ruh.ac.lk